Importance Measures

The aim is to quantify the contribution of components or basic events to the considered measure of system performance. How? Ranking and categorizing with respect to:

- *risk-significance*: if the component failure/unavailability contributes significantly to system risk measure (how much a component is relevant for causing a failure)
- *safety-significance*: if the component plays an important role in the prevention of system undesired states (how much a component is relevant for a system operation)

Hypotheses:
- n binary components (0/1)
- measures adopted:
  system reliability $R(t)$ from the safety point of view
  system failure $F(t) = 1 - R(t)$ from the risk point of view
- $\underline{r}(t) = (r_1(t), .., r_n(t))$ vector of the component reliabilities at time t
- $R(\underline{r}(t))$ system reliability

Importance measures:

1. **Birnbaum's measure** I^B
2. **Criticality measure** I^{cr}
3. **Fussel-Vesely importance measure** I^{FV}
4. **Risk Achievment Worth (RAW)** RAW
5. **Risk Reduction Worth (RRW)** RRW

$$I_j^B = \mathbb{P}(X_T = 1 \mid X_j = 1) - \mathbb{P}(X_T = 1 \mid X_j = 0) = \frac{\partial r}{\partial r_j}$$

$$I_j^{cr} = \frac{I_j^B \cdot \mathbb{P}(X_j = 1)}{\mathbb{P}(X_T = 1)}$$

$$I_j^{FV} = \frac{\mathbb{P}(X_T = 1) - \mathbb{P}(X_T = 1 \mid X_j = 0)}{\mathbb{P}(X_T = 1)} = \frac{\mathbb{P}(\text{failure}) - \mathbb{P}(\text{failure} \mid j \text{ works})}{\mathbb{P}(\text{failure})}$$

$$RAW_j = \frac{\mathbb{P}(X_T = 1 \mid X_j = 1)}{\mathbb{P}(X_T = 1)} = \frac{\mathbb{P}(\text{failure} \mid j \text{ failed})}{\mathbb{P}(\text{failure})}$$

$$RRW_j = \frac{\mathbb{P}(X_T = 1)}{\mathbb{P}(X_T = 1 \mid X_j = 0)} = \frac{\mathbb{P}(\text{failure})}{\mathbb{P}(\text{failure} \mid j \text{ works})}$$

actually the "|" (given) are "," (and)

→ show that I_j^B can be seen, under proper assumptions, as the probability of component j being critical